NEAR-INFRARED MOLECULAR SPECTROSCOPY USING NICE-OHMS WITH HIGH FINESSE CAVITY

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Noise-immune cavity-enhanced optical heterodyne molecular spectroscopy (NICE-OHMS), taking advantage of combining the cavity enhancement and frequency modulation techniques, provides an excellent method to enable ultra sensitive detection. The advantage of noise immunity enables for shot-noise limit detection, particularly for those molecules with ultra-small dipole moments, such as overtone transitions and symmetrical molecules, NICE-OHMS provides a superior strategy to achieve sub-Doppler saturation spectroscopy. Using an optical cavity with a high finesse >100,000, in our previous work, we reported the sub-Doppler saturation NICE-OHMS spectroscopy for nitrous oxide (N_2O) overtone transitions using the quantum-dot (QD) laser developed at 1.28 μm. At a pressure of several mTorr, the saturation dip is observed with a full width at half-maximum of about 2 MHz. The noise equivalent bandwidth-reduced sensitivity is $1.6\times10^{-11}\mathrm{cm}^{-1}\mathrm{Hz}^{-1/2}$. The QD laser is then locked to this dispersion signal with a stability of 15 kHz at 1 s integration time. We demonstrate the potential of the (N_2O) as a marker because of its particularly rich spectrum in the vicinity of 1.28 μm, where there are several important forbidden transitions of atomic parity violation measurements. In current work, we have used a new QD laser system coupled to a high finesse cavity for NICE-OHMS of the H_2 overtone transition S1, where the dipole moment is only 30 mD. The QD laser developed at 1.16 μm is gain-chip based and mounted in an integrated mechanism system to reduce the passive laser linewidth. The cavity finesse was measured to be 234,000 (8000) by using laser-swept cavity ring-down time measurements. After the laser locking, the laser power will be amplified by a fiber amplifier to satisfy saturation condition to achieve sub-Doppler NICE-OHMS spectroscopy.